Argonne National Laboratory
DOE On-Site Review

Advanced Reactor Development

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Argonne's Mission in Nuclear Energy

- Argonne's mission is to serve the nation by advancing nuclear technology for energy, environmental, and national security benefits.
- Argonne is unique: Only remaining national laboratory with a full capability in nuclear technology:
  - Technology
  - People
  - Facilities
- Argonne's goal is to develop and demonstrate the next-generation advanced reactor system so that nuclear is maintained as a long-term energy option, to provide a solution for the nuclear waste problem, and to address non-proliferation concerns.

Requirements for Next-Generation Advanced Reactor

1. Sustainability: Energy potential without resource limit.
2. Safety based on passive characteristics inherent in the technology.
3. Waste management solution.
4. Nonproliferation characteristics.
5. Economics.

The only concept capable of meeting all five requirements is a fast reactor system with an innovative fuel cycle based on pyroprocessing.

1. Sustainability: Resource Extension

- Current commercial reactors utilize less than 1% of uranium resources.
- A fast spectrum reactor is the only reactor type that can accomplish a full utilization of uranium resources.
- Worldwide uranium resources can generate 3,000 quads with current generation commercial reactors versus 500,000 quads with fast spectrum reactors. (Worldwide consumption of coal, oil and gas is about 300 quads/yr.)

2. Passive Reactor Safety

- The landmark tests conducted on EBR-II in April 1986 demonstrated the ultimate passive safety characteristics of the liquid-metal-cooled fast-spectrum reactor, if properly designed.
  - Loss-of-flow without scram from full power
  - Loss-of-heat-sink without scram from full power

3. Waste Management Solution

- Argonne's pyroprocessing can recover minor actinides along with plutonium and recycle them back into the reactor for in-situ burning, at the same time generating energy.
  - This eliminates long-term toxicity of the waste, thereby reducing the lifetime of the waste from millions of years to a few hundreds of years.
  - Technical performance requirements of the repository are greatly reduced.

4. Nonproliferation Characteristics

- The once-through (no recycle) fuel cycle is commonly perceived as the best option.
- Argonne's electrometallurgical technology provides a technical solution:
  - The process cannot separate a pure Pu product that is directly usable for weapons.
  - The product (some U, Pu, minor actinides, some fission products, all combined) is highly radioactive and, hence, self-protecting.
  - The product can be immediately converted into the reactor fuel in the hot cell facility.
- Fast reactors can also be used to burn weapons plutonium.

5. Economics

- Economics of the next-generation reactor must be compared with alternative long-term energy.
- Full life-cycle costs must be considered.
- EBR-II demonstrated over 30 years of safe, reliable operation of a sodium-cooled fast reactor power plant.
  - No steam generator tube leaks
  - Very low corrosion
  - Excellent availability
- Pyroprocessing technology promises major improvements in fuel cycle costs.

National Research Council Committee on Electrometallurgical Techniques for DOE Spent Fuel Treatment

- The EBR-II demonstration project has a high priority.

- "If the EBR-II demonstration is successful, the DOE should revisit the ANL program at that time in the context of a larger, 'global' waste management plan…."

National Energy Policy

- ". . . In the context of developing advanced nuclear fuel cycles and next generation technologies for nuclear energy, the U.S. should reexamine its policies to allow for research, development and deployment of fuel conditioning methods (such as pyroprocessing) that reduce waste streams and enhance proliferation resistance."

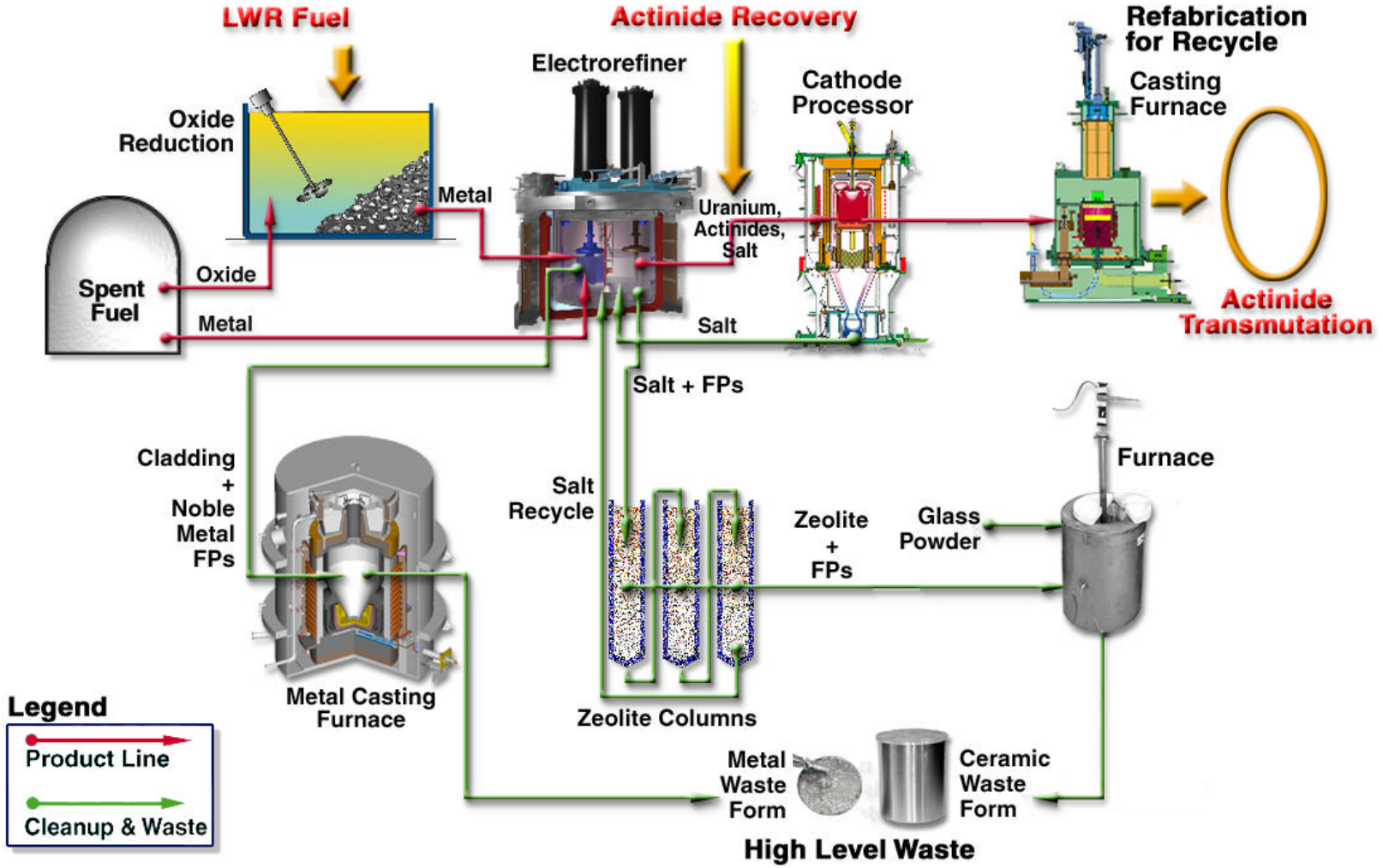
Impact of Pyroprocessing on Nuclear Waste Management

- Pyroprocessing was originally developed for a fast reactor application.
- With a head-end oxide-to-metal conversion step, the process can be adapted to treat the spent fuel inventories from today's commercial reactors.
- Pyroprocessing does not obviate the need for the Yucca Mountain repository. It allows the technical performance requirements for such a permanent repository to be met more easily and reduce the burden of long-term stewardship, resulting in significant improvements in the licensing process and economics.

Proposed Program

- Complete a prototype demonstration of pyroprocessing-based fuel cycle utilizing existing facilities at Argonne-West.
- A commercial-scale demonstration project involving an advanced fast reactor and accompanying fuel cycle facility for an integrated demonstration.
  - Technology for a sustainable, long-term energy supply
  - Recovery of actinides from spent fuel and transmutation in fast reactor
  - Burning of excess weapons plutonium

Pyroprocess Demonstration Status



Summary

- A successful pyroprocessing demonstration at Argonne-West facilities will form the foundation for establishing a commercial-scale demonstration project involving an advanced fast reactor and accompanying fuel cycle facility for an integrated demonstration of reliability, safety, economics, proliferation resistance, and waste management.